

APPLICATION OF CURRENT SCIENCE AND NEW RESEARCH

Assessing the Environmental Effects of Marcellus Shale Gas Development: The State of the Science

Pinchot Institute for Conservation

Philadelphia, PA

April 1, 2011

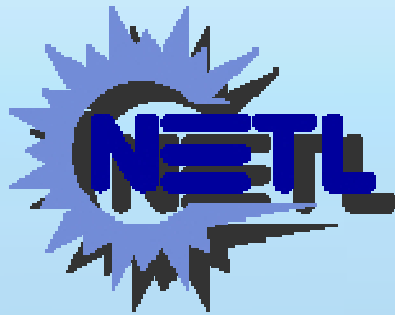
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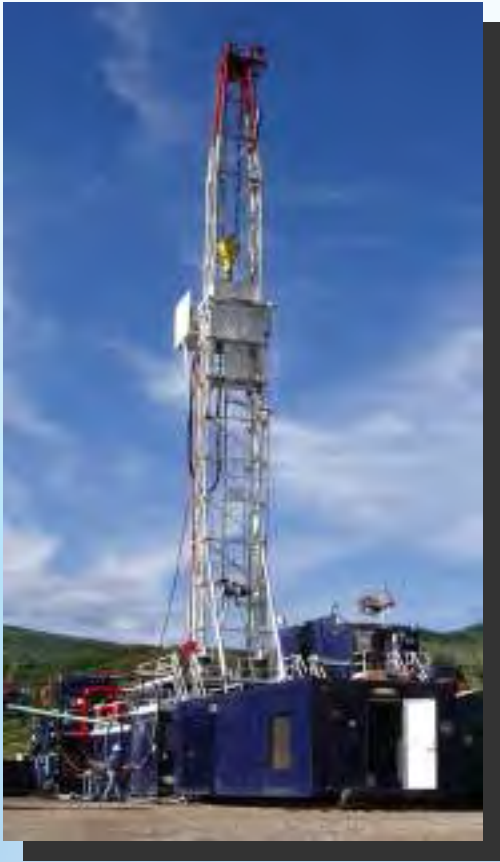
ACKNOWLEDGEMENT



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- Part of NETL's program to promote domestic natural gas production by providing technologies to overcome the technical and environmental challenges associated with unconventional resources.

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INTRODUCTION



- Lifecycle Water Management
- Produced Water Management
- Risk Assessment of Hydraulic Fracturing
- Effective Management Practices

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LIFECYCLE WATER MANAGEMENT

- Model and Tracking System
 - Allow regulators to project water demand by watershed based on various development scenarios
 - Allow operators to plan water needs and permits
 - Allow operators to track permits and reporting requirements

PRODUCED WATER TREATMENT

Produced Water Treatment Catalog and Decision Tool

- Management options
- Treatment goals and options
- Selection criteria

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PW MANAGEMENT OPTIONS

- Three Basic Options
 - Injection
 - Surface Discharge/Beneficial use
 - Reuse in HVHF
- All options have challenges

TREATMENT GOALS

- Three primary treatment goals
 - Reduce TDS (desalination) for discharge/beneficial use
 - Reduce volume for disposal
 - Reduce TDS, scaling, and/or bio-fouling for reuse or UIC

TREATMENT CHALLENGES

- Shale gas produced water quality varies
 - Between plays
 - Within plays
 - Over time
- High Total Dissolved Solids (TDS) concentrations limit treatment options
- All treatment processes result in a waste stream – may be liquid, solid, or both
- All of the PW management options and treatment goals may be inter-related

SELECTION CRITERIA

- Social/Community
- Environmental
 - Conservation of Resources
 - Aquatic Impacts
- Economic
 - Cost of withdrawals
 - Cost of transportation
- Technical
 - Lack of injection capacity
 - Treatment limitations
 - Treatment availability
- Company policies



MIXING AND SCALE AFFINITY MODEL

- Predicts chemical composition of mixed waters, allowing the user to see how waters will react when mixed
- Analyzes the mixing of multiple source waters, identifies the affinity for scale formation and the potential species of scale that will be formed
- Identify the most favorable mix ratio of available waters to meet specified targets for quality parameters – create an engineered water
- www.all-llc.com/projects/produced_water_tool/



TREATMENT OPTIONS

Desalination

- Thermal Distillation
- Reverse Osmosis

Volume Reduction

- Thermal Evaporation
 - Using waste heat

Microbial Control

- Ozone/UV
 - reduces chemical biocides
 - Reduces residual kill capacity



TREATMENT AVAILABILITY



- Availability varies by basin
- New vendors entering the market almost daily
- Several pilots underway/planned



- Treatment for shale gas PW remains in it's infancy

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RISK ASSESSMENT OF HYDRAULIC FRACTURING

- New Study in Canada
- Science and Community Environmental Knowledge fund (SCEK) and Alberta Upstream Petroleum Research Fund (AUPRF)
 - Risks from surface management of chemicals
 - Risks from hydraulic fracturing
 - Risks from management of produced water

EFFECTIVE MANAGEMENT PRACTICES (EMPS)

U.S. DOE Project to identify existing and emerging EMPs

- Multi-well pads
- Green chemicals
- Produced water
 - Handling
 - Reuse

Evaluate Trade-offs

Watch for unintended consequences

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